

# ON THE REPRODUCTIVE SYSTEM OF *DIGASTER* (*DIDYMOGASTER*) *SYLVATICUS*, FLETCH.

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(Plates liii.-liv.)

The present paper contains an account of the reproductive organs of the above-mentioned Earthworm, based on dissections and serial sections, and is to be regarded, so far as concerns this system of parts, as supplementary to the account given by Mr. J. J. Fletcher in his diagnosis of the genus, published in the Proceedings of this Society for the year 1886.\*

**Female organs.**—My observations on the female organs are in complete agreement with those of Fletcher as described by him.

They comprise a pair of ovaries, a pair of oviducts, and three pairs of spermathecae.

(a) *Ovaries*—The two ovaries (fig. 1, *ov.*) are attached to the anterior septum of segment xiii., and hang freely from it into the coelom. In the mature worm the free end of each ovary is frayed out into a number of processes consisting of strings of ova in different stages of development. The mature ovum measures in diameter about .08 mm, is spherical in shape and invested by a definite membrane. Its nucleus is placed excentrically, and contains a deeply-staining nucleolus. In young females the ovaries resemble the testes in shape. Egg-sacs are not present.

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\* Fletcher, J. J. Notes on Australian Earthworms, Part i. P.L.S.N.S.W. (2) i. 1886, p. 554.

(b) *Oviducts*.—The oviducts are a pair of short ciliated tubes with muscular walls, whose swollen ciliated funnels (fig. 1, *f.o.*) open in the hinder part of segment xiii. After perforating the mesentery between segments xiii-xiv., the tubes pass obliquely downwards and backwards through the body wall to open by the small oviducal pores (fig. 2 *op. o.*) situated, one on either side of the mid line, in segment xiv.

In one specimen examined, in addition to normal ovaries and oviducts in the usual position, there is present an extra complete oviduct (fig. 3, *o'.*) on the left side in segment xii. This perforates the mesentery between segments xii., and xiii., and opens to the exterior in the latter segment. An extra ovary was not observed. So far as I can learn from recorded cases of variation\* in the reproductive system of Oligochaetes, the present appears to be the only case on record in which an extra oviduct has been found unassociated with a corresponding ovary.

(c) *Spermathecae*.—There are, as Fletcher† describes, “three pairs of somewhat rounded or pyriform spermathecae, a pair in each of segments vii.-ix., and of which the posterior pair are sometimes the larger” (fig. 1, *sp.' sp." sp. "'*). Each spermatheca is furnished antero-ventrally with a small pear-shaped diverticulum, the stalk of which is connected with the duct of the spermatheca. Their ducts, which are comparatively large and muscular, run backwards in the body wall to open “to the exterior two segments behind those which contain the spermathecae to which they belong,” viz., on segments ix., x., and xi. The spermathecal pouches are lined by a single layer of tall columnar non-ciliated cells and do not contain spermatozoa. Their ducts are lined by an epithelium, which is not the same throughout its extent. For about one-third of the thickness of the body wall the lining consists merely of invaginated epidermis differing in no way from that of the outer surface of the body. Over the

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\* W. Bateson. Materials for the Study of Variation, pp. 160-165.

† *Loc. cit.*, p. 558.

remainder of the duct the lining consists of tall narrow columnar cells, whose ends, bordering on the lumen of the duct, stain lightly, while the main portions of the cells, especially their inner ends, stain very deeply. The diverticulum differs considerably in its histological character from the pouch itself. The lumen of its narrow stalk is essentially similar to that of the main duct, though the cells are smaller, while the interior of the diverticulum is lined by an irregularly-ridged epithelium with bundles of spermatozoa attached between the ridges. The muscular investment of the diverticulum further is much thicker than that of the main pouch. In a young specimen 32 mm. in length (preserved) the spermathecae are represented by simple invaginations of the epidermis .3 mm. in length, extending to about the middle of the thickness of the body wall.

**Male organs.**—These comprise two pairs of testes (fig. 1, *a.t.*, *p.t.*); two pairs of funnels (*a.r.*, *p.r.*) leading into a pair of vasa deferentia (*v.d.*); two pairs of lateral seminal vesicles (anterior and posterior, *a.s.s.*, *p.s.s.*); two median sperm reservoirs (*a.s.r.*, *p.s.r.*) occupying a segment each; and a pair of bilobed spermiducal (prostate) glands (*sp.g.*).

Following Hensen's terminology in use at the time Fletcher wrote his account, the median sperm reservoirs and the seminal vesicles are described as the testes, and as a consequence the true testes were not observed.

(a) *Testes*.—The two pairs of testes (*a.t.*, *p.t.*) are situated in segments x. and xi. Each is a somewhat pear-shaped body, attached by its broader end to the anterior septum of the segment. Opposite the testes, and situated in the posterior portion of the segments, are the rosettes (*a.r.*, *p.r.*) of the vasa deferentia, whose ciliated lips are very greatly folded. The duct from the anterior rosette of each side is joined by the duct from the posterior rosette about the middle of segment xii., (fig. 1, *v.d.u.*), thence the vas deferens (*v.d.*) passes back as a straight, exceedingly slender tube (.019 mm. in diameter) lying below the cœlomic peritoneum and partially embedded in the musculature of the

body wall. At its posterior end it penetrates the base of the prostate gland and joins the main muscular duct of the latter at the point where it, just formed by the union of several small ducts, is about to enter the body wall. The short conjoint ducts open by two slit-like pores situated on prominent papillæ on segment xviii.

In the immature specimen already referred to, the vasa deferentia are in an exceedingly interesting condition. The two ducts from the anterior and posterior rosettes of each side, instead of uniting in segment xii., remain distinct throughout their entire course. On the one side they appear to join the duct of the prostate separately, while on the other appearances suggest that the two ducts unite before entering the common duct. There are thus present in this young specimen two distinct pairs of vasa deferentia. Whether the single vas deferens of each side in the adult arises through fusion of the two ducts present in the young, or whether one of the two primitive ducts disappears, future investigation must decide. In this connection it is worthy of note that according to Beddard\* in embryos of *Octochatus* there are at first traces of four genital ducts in correspondence with the four gonads (there being in those embryos an additional pair of ovaries in segment xii.).

(b) *Sperm reservoirs*.—In segments x. and xi. the anterior and posterior testes and rosettes, together with the ventral nerve cord and the ventral vessel, are enclosed in two medianly situated special compartments of the cœlom functioning as sperm reservoirs. In fig. 1 the right side halves of the reservoirs are shown intact (*a.s.r.*, *p.s.r.*), while on the left they have been opened to expose the contained organs. The cavity of each reservoir is undivided, and contains numbers of developing sperms (fig. 2).

(c) *Seminal vesicles*.—Into the reservoirs there open the seminal vesicles or sperm sacs, of which there are two pairs, situated in segments ix. and xii. The anterior vesicles (*a.s.s.*) are

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\* Beddard, F. E. A Monograph of the Order of Oligochæta, p. 104.

outgrowths of the posterior septum of segment ix., the posterior (*p.s.s.*) are outgrowths of the anterior septum of segment xii. They are comparatively large, smooth, white bodies, which are prolonged into finger-shaped processes, terminating in whip-like extremities. The cavity of each is divided up into a series of inter-communicating compartments in which developing sperms also occur. The fully developed sperms, with an average length of  $\cdot 07$  mm., become attached in bundles by their heads to the ciliated epithelium of the rosettes. In the immature specimen the sperm reservoirs have already attained the adult condition, while the seminal vesicles are represented by small digitiform outgrowths of the septa.

(d) *Spermiducal (Prostate) glands*.—These are, as Fletcher describes, a pair of large flattened bilobed masses situated in segment xviii., and confined to that segment (fig. 1, *sp.g.*). The lobes are invested by peritoneum and are richly supplied with blood vessels. They present the usual structure, *i.e.*, the finer ductules into which open the large glandular cells unite to form larger ducts, and these eventually unite to form a single main duct. This latter, directly after its formation, penetrates the body wall and opens to the exterior on a prominent papilla on the ventral surface of segment xviii. All the ducts are lined by a low columnar epithelium. There do not appear to be any specialised genital or penial setæ in the neighbourhood of the spermiducal apertures. The base of the anterior lobe of each gland is traversed by the vas deferens, which, as already mentioned, opens into the main duct just after its formation.

In the before-mentioned immature specimen the prostate is represented by the common duct, from which sprout out a small number of slightly-branched blindly-ending tubes lined by columnar epithelium. There is as yet no trace of the proper prostatic cells.

*Clitellum*.—The clitellum extends from segment xiii. or xiv. to xviii. Histologically it presents no features of special interest.

## EXPLANATION OF PLATES.

*Reference letters.*

*a.r.* Anterior rosette. *a.s.r.* Anterior median sperm reservoir. *a.s.s.* Anterior sperm sac. *a.t.* Anterior testis. *clit.* Clitellum. *f.o.* Funnel of oviduct. *mes.* ix.-x. Mesentery between segments ix.-x. *neph.* Nephridium. *o.* Oviduct. *o.'* Extra oviduct. *op.o.* Opening of oviduct. *op.o.'* Opening of extra oviduct. *ov.* Ovary. *p.r.* Posterior rosette. *p.s.r.* Posterior sperm reservoir. *p.s.s.* Posterior sperm sac. *p.t.* Posterior testis. *sp.'* *sp."* *sp."* First, second and third spermathecae. *sp.g.* Spermiducal glands. *v.d.* Vas deferens. *v.d.u.* Point of union of the two vasa deferentia. *v.n.c.* Ventral nerve cord.

## Plate liii.

*Digaster (Didymogaster) sylvaticus.*

Fig. 1.—Dissection of the reproductive organs. The left halves of the sperm reservoirs have been removed, exposing the testes and ciliated rosettes of the left side. ( $\times 3$ ).

## Plate liv.

*Digaster (Didymogaster) sylvaticus.*

Fig. 2.—Longitudinal section passing to one side of median line and including segments ix.-xiv. ( $\times 13\frac{1}{2}$ ).

Fig. 3.—Longitudinal section showing presence of extra oviduct, *o.'* ( $\times 42$ ).